EUBREWNET
RBCC-E calibrations
REGIONAL BREWER CALIBRATION CENTER-EUROPE
CEOS-ESA CALVAL campaigns instrumental findings

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Outline

- Brewer ozone Calibration
- Instrumental issues
  Ozone cross section
  Filter nonlinearity
  Dead Time
  Stray Light
- One parameter vs two parameter
Brewer Calibration

\[
O_3 = \frac{F - ETC}{\alpha \cdot m}
\]

- 1: Instrumental Calibration (F)
- 2: Wavelength Calibration (\(\alpha\))
- 3: ETC transfer.
Instrumental calibration

\[ F = F(\text{DeadTime, Filter, Temperature}) \]

- Characterization test determine /track the changes
- Test are well described on Brewer SOP
Wavelength Calibration

1. Optimized wavelengths (Sun Scan)
2. Dispersion test, (discharge lamps)
3. Ozone Cross Sections (Bass & Paur -45).

\[ \tilde{\alpha}(X, \mu) = \sum w_i \frac{\int \alpha(\lambda) * S(\lambda, \lambda') * F(\lambda, \lambda', X, \mu) d\lambda'}{\int S(\lambda, \lambda') * F(\lambda, \lambda', X, \mu) d\lambda'} \]

\( \alpha(\lambda) = \) ozone cross section \( \quad \) \( Wi = \) ozone weighting coefficients

\( S = \) Slit Function, (ILS) \( \quad \) \( F = \) Sun Spectra , (X, nu)

ETC transfer

The reference instruments, the ETC are calibrated by Langley extrapolation.
The network instrument, the ETC is obtained by comparison with the reference.
Before year 2000, ozone absorption cross section and ETC were transferred from the reference.

For a one point calibration there is a dependence through the ozone from a reference (Savastiouk 2009)

\[ O'_3 = O_3 \times \left[ 1 - \frac{O_3 \times \mu}{O_3 \times \mu} \right] \left[ 1 - \frac{\alpha_{ref}(dm)/\alpha_{ref}(bp)}{\alpha_{inst}(Dm)/\alpha_{inst}(bp)} \right] \]

There is no effect on ETC transfer with the change of ozone absorption coefficients with a two point calibration.
Instrumental issues found at CEOS campaigns

a. Ozone Absorption: Two point vs. one point calibration
b. Stray Light
c. Dead Time
d. Filter Attenuation
e. Stray Light
Ozone Absorption coefficient

About one third of the instruments the ozone absorption calculated are not agree with the calibration setting. They are using two parameters calculation.
Straylight

Reference instruments are affected by stray light
Limits the useful calibration range

AEMET, Agencia Estatal de Meteorología
Stray Light

- The empirical relation found at SAUNA with campaigns can be applied to ETC transfer
  \[ ETC = ETC_0 + a(osc)^s \]
Instrumental issues

DT

a. The SOP indicates a tolerance 2 ns.
b. Effect up to 3% in single Brewer
c. The setting on the instrument are not agree with the calculation
d. This also affects to some “reference” instruments like #157 and #017
Filter attenuation:

Attenuation Filters are “neutral”
Nominal wavelengths and weights verify

\[ \sum_{i=1}^{4} w_i = 0, \quad \sum_{i=1}^{4} w_i \lambda_i = 0 \]

If the attenuation is linear with wavelength, do not affect the ozone calculation.
The filters can not be neutral and

\[ \sum_{i=1}^{4} w_i \lambda_i \approx 0 \]

The effect is a correction on ETC for the affected filter \((j)\), that can be calculated if you know the spectral attenuation \(AF\)

\[ ETC - C(j) = \sum_{i=1}^{4} w_i A_f(\lambda_i, j) \]
The instruments calibrated with two point calibration are the same that are affected by filter issues.

**Coincidence?**

No linearity of the filters are not take in to account on the current analysis software, the “synthetic” absorption coefficient can compensate this.
Summary / Conclusions

- A significant number of brewers use two parameters calibration to compensate no linearity's.
- If a proper calibration is use both calibrations are agree, and this agreement can be use as indication of the quality of the instrument.
  - Class I: ETC (+/- 5 units .4% , $o_{3abs}$ +/- 1 step 0.3% )
  - Class II : ETC (+/- 10 units .8%, $o_{3abs}$ +/- 2 step .6%)
- About 2/3 of the instruments shows an agreement of +/-0.5% after two year calibration.
Summary / Conclusions

- Filter Spectral configuration is desirable to include in the configuration file and on the brewer processing software.
- Two wavelengths calibration (ozone, and UV) are not desirable but is a compromise solution.
- Is not always possible to get/determine who parameter is casing the no-linearity in this case we two point calibration could be used.

- Ongoing work
  - DT from the sun
  - Instrumental constants from langley.
\[
O_3 = \frac{\sum_{i=1}^{4} w_i \cdot \left[ \log(F_i) - \log(F_{0i}) - AMF_{SCA} \cdot \frac{p}{p_0} \cdot \tau_{SCAi} \right]}{AMF_{O3} \cdot \sum_{i=1}^{4} w_i \cdot \tau_{O3i}}
\]

Weights \( w_i \): \(-1, +0.5, +2.2, \) and \(-1.7\)

Wavelengths: \(310, 313, 317, \) and \(320\) nm.

\(F_0\): extraterrestrial count rates.

\(F\): measured count rates

\(P_0, p\): standard surface air pressure /average station air pressure

\(T_{SCAi}\): molecular scattering optical depths for each wavelength \(i\) at \(p_0\).

\(T_{O3i}\): ozone absorption optical depths for each wavelength \(i\).

\(AMF_{SCA}\): direct sun air mass factors for molecular scattering

\(AMF_{O3}\): direct sun air mass factors for ozone absorption respectively.

\[AMF_x = \sec \left\{ \arcsin \left[ \frac{R}{R + h_{EFFx}} \cdot \sin(SZA) \right] \right\}\]

\(R\) is the Earth’s radius (6370km)

\(h_{EFFx}\) is the effective layer height. (It is set to \(h_{EFFSCA}=5\) km and \(h_{EFFO3}=22\) km.